

**Remarks:**

Claims 1-21, 30-37, and 45 remain for consideration in this application. In view of the foregoing amendments and remarks hereunder, the rejections of the last office action are respectfully traversed.

The present invention pertains to highly reactive nanocrystalline compositions that include at least two different nanocrystalline materials. It is an essential and novel feature of the present invention that the different nanocrystalline materials be solidified and intimately intermingled at a level that is commensurate to the crystallite size of at least one of the materials. This is to say, that the different materials must be dispersed among each other at a nano-level. This intimate intermingling at a nano-level cannot be accomplished through simple mechanical mixing, but rather is a result of the process by which the nanocrystalline materials are prepared.

Turning now to the office action, the Examiner made several formal objections to the claims. Applicants submit that these formal objections have been directly obviated or indirectly addressed by way of amendment.

The Examiner rejected claims 1, 4, and 15 under 35 USC §112, first paragraph, due to the phrase "about 0" appearing therein. Applicants have amended these claims to remove the "about 0" terminology so that the claims now read that the materials exhibit average crystallite sizes of up to about 4 nm. A similar rejection was made under 35 USC §112, second paragraph, with respect to claim 1 that is also remedied by this amendment.

Applicants have also identified the periodic table referred to in claims 1, 12, and 30 as being the CAS table. Given the list of individual metals recited in the specification, it is clear that the

periodic table system being referred to is the CAS table. For example, the specification notes that aluminum is a preferred metal ion component of the hydroxides and oxides. Aluminum is a member of Group IIIA of the CAS table.

Claims 6, 7, and 17 have been amended to replace the word solid appearing in the last line of each claim with the term "material". This amendment is consistent with the terminology used in the preceding line of each claim that refers to "nanocrystalline materials".

Applicants have amended claims 9 and 19 in order to delete the MgO species from the "non-binary" material. Applicants believe that this was a typographical error and have accordingly amended the specification on page 4, the paragraph beginning at line 18, in order to rectify this error.

The Examiner also rejected claims 1 and 12 under 35 USC §112, second paragraph, noting that the phrase "intimately intermingled on a molecular level" is indefinite. First, applicants have amended these claims to recite that the materials are intimately intermingled at a "nano-level" in order to provide a more specific scale upon which to judge the requisite intermingling of particles. Support for this amendment can be found throughout the specification, particularly in the figures, and more specifically Figures 13b and 13c. Both of these figures are photographs depicting such intimate intermingling of the different nanocrystalline materials. As shown in the figures, the photographic scale is on the nanometer level. This amendment aside, applicants respectfully disagree that the phrase "intimately intermingled on a molecular level" is indefinite. Applicants have performed a search on the USPTO website and have discovered at least 3 different patents (6,319,484, 5,415,770, and 4,511,667) which use the term "intimately intermingled" in their claims. Applicants submit that by modifying the term "intimately intermingled" with the phrase "at a nano-

level" more specifically defines the meets and bounds of the phrase "intimately intermingled" than do the 3 issued patents. The phrase "intimately intermingled at a nano-level" indicates the presence of nanocrystalline domains such that many nanocrystalline interfaces are present between the different nanocrystalline materials. Applicants respectfully request that the § 112, second paragraph, rejection with respect to this phrase be withdrawn.

Applicants have amended claim 45 by removing reference to withdrawn claim 38 and have instead substituted therefore the actual recitation of the method of preparing the solid oxides.

The Examiner made several 35 USC §103(a) rejections based on a number of references. These rejections will now be addressed in the order they appear in the action.

Turning first to the rejection based on the Carnes reference, Applicants would like to point out that the effective date of this reference noted in the IDS filed February 10, 2003 is 2/21/01. It has since come to Applicants' attention that the noted effective date may be inaccurate. The "2" and the "1" may have been inadvertently transposed. Therefore, it is possible that the effective date of this reference is 2/12/01. In any event, the present application was filed on 2/11/02, less than one year after the effective date of the Carnes reference. Therefore, the Carnes reference does not constitute prior art under §102(b). Furthermore, as Ms. Carnes is an inventor of the present application, the reference does not indicate that the invention was known by others under §102(a). Applicants, therefore, request that the §103(a) rejection over Carnes be withdrawn.

The Examiner rejected claims 1-21 and 45 as being obvious over Lai et al. Lai et al. teach a new zeolite membrane comprising a porous substrate coated with a growth enhancing layer and a layer of columnar zeolite crystals on the growth enhancing layer. As explained below, the

presently claimed composition is distinguishable from each of the layers of the Lai et al. membrane. Beginning with the substrate layer, Lai et al. teach that if the substrate is porous it can be comprised of an inorganic oxide. However, there is no teaching that at least one of the materials forming the substrate exhibits an average crystallite size of up to about 4 nm, nor does Lai et al. teach that the materials making up the substrate are intermingled at a nano-level. In fact, Lai et al indirectly teaches away from the use of a substrate having at least one material exhibiting such a small crystallite size. In column 6, lines 3-6, Lai et al. teach that it is preferable for the surface of this substrate material to be smooth. The presence of such small crystallite sizes within the substrate material would be counterproductive in this regard. The growth enhancing layer and columnar zeolite crystal layer are both completely inapposite to the presently claimed invention. Both of these layers require the presence of zeolite materials. Conventionally, zeolites are aluminosilicates. Lai et al. also teach that aluminophosphates and metalloaluminophosphates are also included in this definition of the term "zeolite." The present claims restrict the nanocrystalline materials in such a way so as to exclude all of the zeolite materials taught by Lai et al. Therefore, under no circumstances could the growth enhancing layer or columnar zeolite layer be anticipatory of the presently claimed articulate composition. Furthermore, Lai et al. teach that the crystal width in the columnar zeolite layer vary from 0.1-20  $\mu\text{m}$  (column 7, lines 55-56). It is a goal of Lai et al. for the zeolite structures to be very ordered and to have as few defects as possible (column 5, lines 23-26). With the inventive materials being highly reactive, structural defects are extremely desirable as they impart high chemical reactivity. In view of the forgoing differences, applicants submit that the

inventive materials are sufficiently distinguished from those taught by Lai et al. and request that the §103(a) rejection to Lai et al. be withdrawn.

The Examiner rejected claims 30-37 and 45 as being unpatentable over Burba, III and Burba, III et al. Turning first to the Burba, III reference, Burba teaches a method of producing a *layered* structure useful in the production of spinels. This layered structure is completely different than the intimate intermingling of oxides and hydroxides as presently claimed. Also, Burba makes no teaching that the metal hydroxide materials are nanocrystalline in structure. Therefore, Burba is non-enabling in this respect. Turning now to Burba, III et al., the same shortcomings are present as with Burba, III. Burba, III et al. teaches that the crystalline metal hydroxides are layered as opposed to the intimate mixture intimately intermingled metal hydroxides presently claimed. Burba, III et al. also fails to disclose that at least one of the metal hydroxide materials exhibits a crystallite size of up to about 4 nm. Furthermore, the question of inherency of the presently claimed characteristics is easily addressed by examining the uses of each material and the method in which it is produced. The materials of Burba, III et al. are coating formulations which behave as elastic solids having reversible stress-induced fluidity and are formed by mixing a solution of metals and hydroxyl ions. The inventive compositions are formed by separate preparation of different alkoxide solutions each containing a metal ion moiety and mixing and hydrolyzing the alkoxide solutions to form a gel and then drying the gel to yield a solid hydroxide composition. It is this sol-gel preparation route that leads to the nano-level mixtures of metal hydroxides. If desired, the composition can be heated. In this approach, there are two points where the unique "nano-level intimate mixing" can take place and/or be controlled: (1) During hydrolysis and subsequent gel formation, segregation of the first

metal hydroxide/oxide from the second metal hydroxide/oxide due to slightly different hydrolysis rates, and (2) During drying and subsequent heating where phase segregation at the nano-level can be controlled. This nano-level intimate intermingling between particles has not yet been achieved in any other way. In view of the forgoing distinctions between Burba, III and Burba, III et al. and the present invention, Applicants request that this rejection be withdrawn.

The Examiner rejected claims 1-21 and 45 over Koper et al. ('488). Koper '488 teaches finely divided nanoscale metal oxide adsorbants that are *coated* with a second metal oxide or have reactive atoms stabilized on their surfaces. Again, this teaching of a coating is analogous to the layered teachings of Lai and Burba, III in that there is no intimate intermingling of the different metal oxide materials. The same can be said of Klabunde et al. which teaches metal oxide particles having oxygen ion moieties on their surfaces with reactive atoms interacted or chemisorbed with those surface oxygen ions. Klabunde et al. do not teach the intimate intermingling of metal oxide particles on a nano-level.

Finally, the Examiner rejected claims 1-21, 30-37, and 45 as being unpatentable over Koper et al. '519. The Examiner references the abstract of Koper '519 as teaching the presently claimed solid oxide or hydroxide composition. However, Koper '519 very specifically recites that the compositions disclosed therein comprise a metal oxide or metal hydroxides having reactive atoms stabilized or species adsorbed on their surfaces, or are *coated* with a second metal oxide. As with Koper '488 and Klabunde et al., Koper '519 does not teach the intimate intermingling of different metal oxide or hydroxide as presently claimed, but rather teaches coatings or surface stabilized

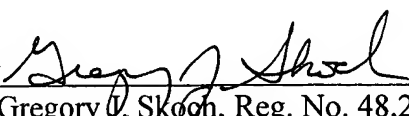
species on metal oxides. There is no intermingling of the coating material and the base metal oxide or hydroxide on a nano-level as presently claimed.

Claim 45 is a "product-by-process" claim directed toward solid oxides produced according to a unique method. The specification of the present application shows that following the claimed process produces a nanocrystalline material comprising at least two metal oxides intimately intermingled on a nano-level. None of the references cited by the Examiner teach this method nor do any of the references teach similar materials (i.e., metal oxides intimately intermingled on a nano-level). Applicants have demonstrated that the method of producing solid oxide materials is new and, by way of the arguments distinguishing the references cited by the Examiner, that the oxides themselves which have only been produced by this method are new. Therefore, claim 45 is free of the art of record in this case.

Any additional fee which is due in connection with this amendment should be applied against our Deposit Account No. 19-0522.

In view of the foregoing, a Notice of Allowance appears to be in order and such is courteously solicited.

Respectfully submitted,

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